Roger Thomas looks at decoding RDS

Decoding RDS Part 1

In the first part of his three-part series on decoding RDS, Roger Thomas looks at the background to this data system that was developed to make VHF FM broadcast receivers more user-friendly.

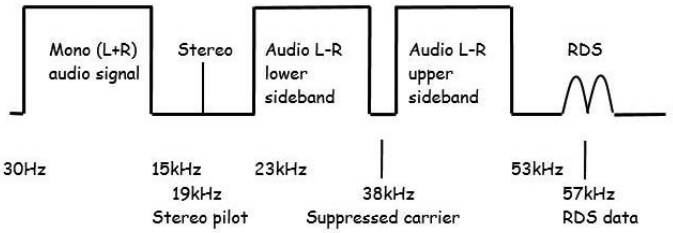

Fig. 1: Spectrum showing the VHF FM stereo multiplex and RDS carrier.

Block A	10-bit check word	Block B	10-bit check word	Block C	10-bit check word	Block D	10-bit check word
16 bits PI number		16 bits of data		16 bits of data		16 bits of data	

Fig. 2: An RDS data group comprises four blocks of data with 26 data bits per block (total 104 bits).

Table 1: RDS Syndrome Values in Hexadecimal

Block	Syndrome	Value (Hex)
A	A	3D8
B	B	3D4
C	C	25C
C	C'	3CC
D	D	258

Table 2: Block A PI Definition

This block is transmitted in every RDS group.

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Country Code (Hexadecimal) 0 = not used 1 = DE, GR, MD, MA 2 = DZ, CY, CZ, EE, IE 3 = AD, PL, SM, TR 4 = IL, MK, CH, VA 5 = IT, JO, SK 6 = BE, FI, SY, UA 7 = LU, RU, TN 8 = PT, BG, NL, PS 9 = AL, DK, LV, LI, SI A = AT, GI, IS, LB B = HU, IQ, MC C = HR, LT, MT, GB D = DE, LY, YU E = ES, RO, ES, SE F = BY, BA, EG, FR, NO				Coverage Area (Hexadecimal) 0 = Local 1 = International 2 = National 3 = Regional 4 = Region 1 5 = Region 2 6 = Region 3 7 = Region 4 8 = Region 5 9 = Region 6 A = Region 7 B = Region 8 C = Region 9 D = Region 10 E = Region 11 F = Region 12				Unique Radio Station Reference Number (Hexadecimal) National Network Radio Stations (PI number) – 01 – BBC Radio 1 (C201) 02 – BBC Radio 2 (C202) 03 – BBC Radio 3 (C203) 04 – BBC Radio 4 (C204) A1 – Classic FM (C2A1)							

Radio Data System (RDS) is an inaudible data signal added to VHF FM stereo carriers. The European Broadcasting Union (EBU) published the RDS specification in March 1984, with the first RDS broadcasts in the UK in 1987. Similar carrier-based VHF FM data transmission systems existed before the introduction of RDS, including the Mobile Broadcast System (a Swedish radio paging system no longer used within Europe) and the German Autofahrer Rundfunk Information (ARI) system that provided traffic information. ARI ceased operation in 2006.

The RDS system was designed to make VHF FM broadcast receivers more user-friendly by displaying the received station's name, scrolling messages, the date and current time and allow the user to search for a particular programme type. Also, for in-vehicle receivers, automatically switch to an alternative frequency if reception on the current frequency is poor.

RDS Subcarrier

The RDS subcarrier is amplitude modulated with suppressed carrier and a maximum bandwidth of ±2kHz centred on 57kHz (**Fig. 1**). This data signal is locked to three times the 19kHz stereo pilot. However, it is not necessary to have a stereo signal for decoding RDS. This frequency was chosen to avoid data interference with the audio channels on non-RDS receivers.

Each RDS data bit phase modulates the 57kHz subcarrier by plus or minus 90°. The RDS clock frequency is obtained by dividing the transmitted subcarrier frequency of 57kHz by 48. Consequently, the data rate is 57000/48 = 1187.5 bits per second (bps).

RDS Data Groups and Blocks

Each RDS data group is made up of 104 bits comprising four independent blocks of data (**Fig. 2**). Each block is 26 bits in length, comprising 16 bits for conveying information and a 10-bit check word.

The data rate of 1187.5bps means that approximately 11.42 (104 bit) data groups can be transmitted per second and each data group takes approximately 88ms to transmit.

RDS is very efficient, with all of the functions listed broadcast using a maximum of 64 bits of data. In fact, many functions can be encoded using only 37 bits. RDS data is transmitted least significant bit first.

RDS data is synchronous. Hence,

Table 3: Capital FM Switched PI Numbers for Transmitters in the East Midlands

Coverage	Transmitter	Frequency	Network PI Number	Switched PI Number
Nottingham	Mapperley Ridge	96.2MHz	C377	C577
Mansfield	Fishpond Hill	96.5MHz	C377	C477
Derby	Drum Hill	102.8MHz	C377	C677
Leicester	Billesdon	105.4MHz	C377	C777

there is no start/stop data sequence or any inter-block gaps. The addition of 10-bit check words enables data synchronisation and allows the RDS decoder to detect and correct data errors.

RDS decoders rely on the fact that only properly received and synchronised data will pass the check word test by using a 26 by 10-bit lookup table for a bit by bit check on the received RDS data. If the received data is error free, then the result of this Boolean bit calculation will be one of the five possible numbers (referred to as a syndrome in the RDS specification). These five syndromes are listed in **Table 1** as hexadecimal numbers. A properly decoded RDS block will produce one of the syndrome values, which identifies the corresponding RDS block. The occurrence of a C' syndrome indicates that block C contains a Programme Identification (PI) number rather than data, more on this in later.

Block A

The first RDS data block (Block A) always has the Programme Identification number of the radio station being listened to. This PI number is made up of the country code, coverage area (national or regional) and a unique reference number for each radio station (see **Table 2**). This is usually stated as a hexadecimal number although most listeners will see it as letters/numbers rather than a number to the radix or base 16. All PI numbers given here are hexadecimal.

PI numbers are fundamental to how RDS works. In the case of poor reception, it is this number the receiver uses when seeking alternative frequencies for the current radio station or switching to nearby BBC local radio stations for traffic announcements.

With only four bits allocated to the country code (0000 is not used), there are only 15 different country codes. Therefore, countries have to share the same country code, these are assigned to ensure that neighbouring countries do not have the same code. The UK is allocated C, which we share with the distant European countries of Croatia, Lithuania and Malta (**Fig. 3** shows the

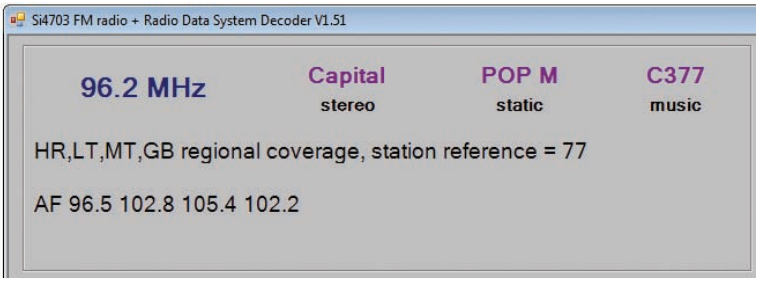

Fig. 3: The PI number for Capital (C377) showing regional coverage.

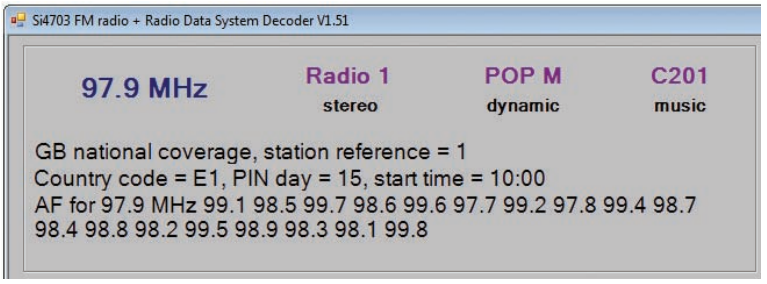
Si4703 FM radio + Radio Data System Decoder V1.51
97.9 MHz
Radio 1
stereo
POP M
dynamic
C201
music
GB national coverage, station reference = 1
Country code = E1, PIN day = 15, start time = 10:00
AF for 97.9 MHz 99.1 98.5 99.7 98.6 99.6 97.7 99.2 97.8 99.4 98.7
98.4 98.8 98.2 99.5 98.9 98.3 98.1 99.8

Fig. 4: The PI number for Radio 1 (C201) showing national coverage and the ECC data (E1) to identify GB.

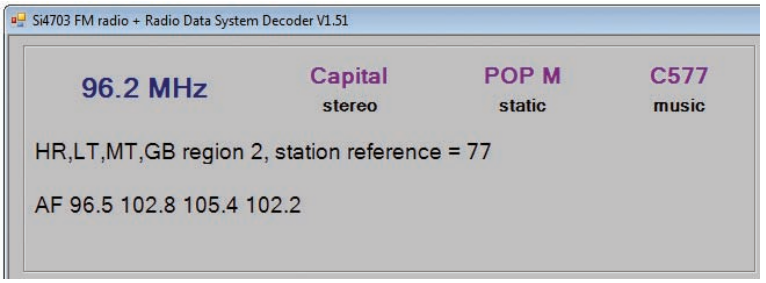

Fig. 5: Capital with switched PI.

regional PI code for Capital). Additional information called Extended Country Code (ECC) is given in group type 1A and this combination then allows for a unique country code (GB = E1). Only the BBC national networks make use of this extended data (as can be seen in **Fig. 4**).

Switched PI

Many of the networked commercial radio stations use switched PI numbers. During networked programming the main PI number is used and the FM receiver can freely switch between transmitters for the best reception because all the transmitters are broadcasting the same programme. However, when adverts (or local programming) are being broadcast, then the switched PI number is broadcast by the relevant group of FM transmitters.

This switched PI number prevents the receiver from switching to another transmitter group because different groups could be broadcasting different adverts – which could be quite distracting, for example, when driving. When the adverts have finished, the PI number reverts back to the national or regional PI number and the receiver can again start looking for alternative frequencies if reception is poor. Note, that where a radio station network has many transmitters, these switched PI numbers can be re-used at distant transmitters. Hence, the switched PI number does not uniquely identify the transmitter site. For example, Capital FM has a regional PI number of C377 but when the adverts are on for the Nottingham area (**96.2 MHz**) the PI number changes to C577 (**Fig. 5**) to prevent the receiver switching to another Capital FM transmitter broadcasting adverts for a different region – see **Table 3**.

Block B

The first four bits in Block B determine the group type of the following data. The fifth bit (B_0) determines the group version. There are two versions of each group

depending on the status of bit B_0. An A or B is appended to the group type, as appropriate. In general, version A (B_0 bit is 0) group will only have the PI number in Block A whereas version B (when B_0 bit is 1) will also have the PI number replicated in Block C.

There are many groups defined in the *Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 to 108,0 MHz – European Standard EN 50067* dated April 1998, which is readily available to download from numerous websites. However, only a few groups are used in the UK.

Many groups are designated as Open Data Applications and thus are not precisely defined in the RDS specification. The coding and implementation are left to the broadcaster. For example, the BBC uses group type 6A (in-house) internally to communicate equipment status and group type 12A (ODA) is used to provide tuning data to enable an FM and DAB receiver to switch between FM and DAB, how this works will be described in Part 3.

The next bit, TP (Traffic Programme) indicates that the radio station currently being received (tuned network) carries traffic announcements (more about traffic announcements later).

The next five bits of Block B contain the programme type (PTY) number. Programme type indicates the radio station's format or the type of programme being broadcast. BBC radio stations have a dynamic PTY, where the PTY number varies reflecting the programme content. Commercial radio stations tend to have a static programme type. Consequently, their PTY number do not change and the PTY defines the station's format. The definition for the rest of Block B (five bits b0 to b4), and Blocks C and D vary according to the group type.

Table 4: Block B Group Type Definitions

RDS group	b15 2^3	b14 2^2	b13 2^1	b12 2^0	b11 B_0	b10 TP	b09 2^4	b08 2^3	b07 2^2	b06 2^1	b05 2^0	b04	b03	b02	b01	b00
							PTY programme type					Function Depends on Group				
0A	0	0	0	0	0		00 = NO PTY					TA	M/S	Dn	C1	C0
0B	0	0	0	0	1		01 = NEWS					TA	M/S	Dn	C1	C0
1A	0	0	0	1	0		02 = AFFAIRS					R4	R3	R2	R1	R0
1B	0	0	0	1	1		03 = INFO									
2A	0	0	1	0	0		04 = SPORT					A/B	T3	T2	T1	T0
2B	0	0	1	0	1		05 = EDUCATE									
3A	0	0	1	1	0		06 = DRAMA					A3	A2	A1	A0	B_0
3B	0	0	1	1	1		07 = CULTURE									
4A	0	1	0	0	0		08 = SCIENCE					--	--	--	2^{16}	2^{15}
4B	0	1	0	0	1		09 = VARIED									
5A	0	1	0	1	0		10 = POP M									
5B	0	1	0	1	1		11 = ROCK M									
6A	0	1	1	0	0		12 = EASY M									
6B	0	1	1	0	1		13 = LIGHT M									
7A	0	1	1	1	0		14 = CLASSICS									
7B	0	1	1	1	1		15 = OTHER M									
8A	1	0	0	0	0		16 = WEATHER					X4	X3	X2	X1	X0
8B	1	0	0	0	1		17 = FINANCE									
9A	1	0	0	1	0		18 = CHILDREN									
9B	1	0	0	1	1		19 = SOCIAL									
10A	1	0	1	0	0		20 = RELIGION									
10B	1	0	1	0	1		21 = PHONE IN									
11A	1	0	1	1	0		22 = TRAVEL									
11B	1	0	1	1	1		23 = LEISURE									
12A	1	1	0	0	0		24 = JAZZ					E/S				
12B	1	1	0	0	1		25 = COUNTRY									
13A	1	1	0	1	0		26 = NATION M									
13B	1	1	0	1	1		27 = OLDIES									
14A	1	1	1	0	0		28 = FOLK M					TP(ON)	V3	V2	V1	V0
14B	1	1	1	0	1		29 = DOCUMENT					TP(ON)	TA(ON)	--	--	--
15A	1	1	1	1	0		30 = TEST					--	--	--	--	--
15B	1	1	1	1	1		31 = ALARM !									

Table 5: RDS Group Types

EON – Enhanced Other Networks
ODA – Open Data Application

RDS Type	Group Description
0A	Basic tuning and switching
0B	Basic tuning and switching
1A	Programme item number and labelling codes
1B	Programme item number
2A	Radio text (64 characters)
2B	Radio text (32 characters) – not used in the UK
3A	Application identification for ODA
3B	ODA – not used in the UK
4A	Clock time and date
4B	ODA – not used in the UK
5A	Transparent data channels or ODA– not used in the UK
5B	Transparent data channels or ODA– not used in the UK
6A	In-house use – BBC only
6B	In-house use or ODA – not used in the UK
7A	Radio paging – not used in the UK
7B	ODA – not used in the UK
8A	Traffic message channel – commercial stations
8B	ODA – not used in the UK
9A	Emergency warning system or ODA – not used in the UK
9B	ODA – not used in the UK
10A	Programme type name – not used in the UK
10B	ODA – not used in the UK
11A	ODA – not used in the UK
11B	ODA – not used in the UK
12A	ODA – BBC only
12B	ODA – not used in the UK
13A	Enhanced radio paging or ODA – not used in the UK
13B	ODA – not used in the UK
14A	EON information
14B	EON information
15A	ODA – not used in the UK
15B	Fast basic tuning

RDS Group Types

For a summary of RDS group types (many of which are not used in the UK), see **Table 5**.

Next Time

In Part 2, I will look at the signalling of traffic announcements (TA), alternative frequencies (AF), programme services (PS) and radio text messages. ●

Roger Thomas continues his look at decoding RDS

Decoding RDS Part 2

In the second part of his three-part series on decoding RDS data, Roger Thomas looks at the background to this data system that was developed to make VHF FM broadcast receivers more user-friendly.

In Decoding RDS Part 1 (*RadioUser*, May 2016: 50-52), I looked at the radio data system (RDS) subcarrier, data groups and blocks, switched Programme Identification (PI) and RDS group types. This time, I look at the signalling of traffic announcements, alternative frequencies, programme services and radio text messages.

Block B RDS Groups 0A and 0B

For details of the encoding for Groups 0A and 0B, please see **Table 6**. When active, the Traffic Announcement (TA) flag (bit 04) indicates that a traffic announcement is currently being broadcast by this station.

The M/S bit (bit 03) indicates whether music or speech is being transmitted, thereby enabling a receiver to have different volume or tone setting to suit the audio content. The default setting is music and it seems that all UK radio stations permanently use the default setting irrespective of the actual audio content being broadcast.

The least significant three bits of Block B give basic information on the audio decoder needed. Bits C0 and C1 select one of the D (b02) options. For example, when C0 (b00) and C0 (b01) are both set to 0, the value of D (b02) determines if the programme is being broadcast in mono (D = 0) or stereo (D = 1). When C0 and C1 are both set to 1, then the value of the D determines whether the programme type (PTY) is static (D = 0) or dynamic (D = 1). In addition, the value of C determines the position of the two characters for the Programme Service (PS) contained in block D.

Block C RDS Groups 0A and 0B

RDS provides a list of Alternative Frequencies (AF) for nearby radio transmitters that are also transmitting the same PI number, hence the same radio programme. The AF is transmitted in Block C of each group type 0A. The AF facility allows dual-tuner receivers to switch seamlessly between frequencies that are carrying identical programming, automatically finding the frequency that offers the best reception. These alternative frequencies can either be mapped to the frequency that the current radio station is transmitting on or to a list.

These alternative frequencies are transmitted as a number rather than the tuned frequency. Number 1 signifies 87.6MHz, 2 signifies 87.7MHz and so on in increments of 0.1MHz up to 204 (107.9MHz). The RDS standard also covers alternative frequencies for medium and long wave. However, this feature is not currently used in the UK. All the AF codes are listed in **Tables 7** and **8**.

If there are no alternative frequencies, then the filler code (205) is transmitted. If there are no alternative frequencies, then type 0B can be transmitted and Block C carries the station's PI number.

Block D RDS Groups 0A and 0B

This block carries the Programme Service (PS) text for the current station, with two PS characters in each block. This is the eight-character name of the radio station that is displayed so that the listener knows what station the receiver is tuned to. This group is transmitted more frequently than other groups because a total of four type 0A groups are required to transmit the entire PS name.

All PS names are eight characters long. If the station's name is less than eight characters long, then spaces are added. The PS is for the listener's information only and not used by the tuner to find alternative frequencies and so on. Thus, different radio networks might refer to the same PI number but with a slightly different PS. For example, Classic FM refers to Radio 1 as BBC 1 FM. However, the BBC identifies Radio

Table 6: Definition of Block B for Groups 0A or 0B

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group Type				B_0	TP	PTY programme type					TA	M/S	D 0 – Mono 1 – Stereo 0 – Not binaural 1 – Binaural 0 – Not compressed 1 – Compressed 0 – Static PTY 1 – Dynamic PTY	C1 0 0 1 1	C0 0 1 0 1
0	0	0	0	X											

Table 7: Alternative Frequency (AF) Codes for VHF FM

Code	Meaning
0	Not used
1	87.6MHz
2	87.7MHz
3 to 202	87.8 to 107.7MHz in 0.1MHz steps
203	107.8MHz
204	107.9MHz
205	Filler code
206 to 223	Not assigned
224	No AF
225	1 AF exists
226	2 AF exists
227 to 247	3 to 23 AF exist
248	24 AF exists
249	25 AF exists
250	LF/MF AF follows
251 to 255	Not assigned

1 as Radio 1 (PI = C201) but refers to Radio 2 as BBC R2.

For the definition of Block D groups 0A and 0B, see **Table 9**.

Block C RDS Group 1A

Block C provides the Extended Country Code (ECC) and several other options – see **Tables 10** and **11**. The Programme Item Number (PIN) in Block D is the scheduled start day and time of the radio programme and enables a suitable receiver to record a particular programme **–** see **Table 12**. However, I have not seen any FM receiver that takes advantage of this information for recording.

RDS Group 2A

With this group, broadcasters can send radio text messages of up to 64 characters in length for display on a suitably equipped RDS receiver – see **Tables 13**, **14** and **15**. Each type 2A group carries a total of four characters, with Blocks C and D each carrying two text characters. Bits T3, T2, T1 and T0 determine the text character position on the display.

The A/B flag (bit 04) is used to indicate whether the text message should overwrite the existing message or if the display should be cleared before a new message is displayed. Observing the radio text message is a good indication of the received quality of the RDS signal. If any data in a type 2A group block is missing, then potentially four consecutive text characters will be lost. Alternatively, if reception is poor, then random characters could be displayed. The same text message is broadcast several times to ensure correct reception.

RDS Group 3A

The type 3A group gives information about which Open Data Application (ODA) groups are being broadcast for the current RDS transmission – see **Table 16**. The 3A group comprises the application group type number used by the ODA application. The 16 data bits in Block C can be used directly by the defined ODA group.

The Applications Identification (AID) number is broadcast in Block D and used to uniquely identify a particular

Table 8: AF Codes for the Long and Medium Wave Bands (based on 9kHz channel spacing)

Code	Frequency
1 (LF)	153kHz
2 to 14 (LF)	162 to 270kHz incrementing in 9kHz steps
15 (LF)	279kHz
16 (MF)	531kHz
17 to 134 (MF)	540 to 1593kHz incrementing in 9kHz steps
135 (MF)	1602kHz

Table 9: Definition of Block D for Groups 0A or 0B

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Programme Service (PS) name C1, C0 = 00 Character position 1 C1, C0 = 01 Character position 3 C1, C0 = 10 Character position 5 C1, C0 = 11 Character position 7								Programme Service (PS) name C1, C0 = 00 Character position 2 C1, C0 = 01 Character position 4 C1, C0 = 10 Character position 6 C1, C0 = 11 Character position 8							

Table 10: Definition of Block B for Group 1A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 1A				B_0	TP	PTY programme type					R4	R3	R2	R1	R0
0	0	0	1	0							Radio Paging codes (Not used in the UK)				

Table 11: Definition of Block C for Group 1A

The Linkage Actuator (LA) bit for linking radio services with different PI numbers to be treated as a single service when a common programme is being broadcast.

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
LA	0	0	0	Radio Paging (RP)				Extended Country Code (GB = E1)							
LA	0	0	1	Traffic Message Channel (TMC) identification Not needed if TMC data using Group 8A											
LA	0	1	0	Paging identification											
LA	0	1	1	Language code, including 05 (Welsh), 09 (English) and 12 (Gaelic)											
LA	1	0	0	Not defined											
LA	1	0	1	Not defined											
LA	1	1	0	For use by broadcasters											
LA	1	1	1	Identification for Emergency Warning System (EWS) channel											

Table 12: Definition of Block D for Group 1A (PIN data)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
2^4	2^3	2^2	2^1	2^0	2^4	2^3	2^2	2^1	2^0	2^5	2^4	2^3	2^2	2^1	2^0
Day (1 to 31) If 0, then no PIN					Hour (0 to 23)					Minute (0 to 59)					

Table 13: Definition of Block B for Group 2A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 2A				B_0	TP	PTY programme type					A/B	T3 0 :: 1	T2 0 :: 1	T1 0 :: 1	T0 0 :: 1
0	0	1	0	0											

Table 14: Definition of Block C for Group 2A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Radio Text message T3=0 T2=0 T1=0 T0=0 Character position 1 T3=0 T2=0 T1=0 T0=1 Character position 5 ..... T3=1 T2=1 T1=1 T0=1 Character position 61								Radio Text message T3=0 T2=0 T1=0 T0=0 Character position 2 T3=0 T2=0 T1=0 T0=1 Character position 6 ..... T3=1 T2=1 T1=1 T0=1 Character position 62							

application so that the data sent can then be correctly decoded by the appropriate software. Otherwise, the data is ignored by the receiver. These AID numbers are allocated by the European Broadcasting Union (EBU) on application by the broadcaster or data provider. I have only seen data for two different AID numbers used in the UK – see **Table 17**.

AID CD46

There are two operating modes for Traffic Message Channel (TMC) group 8A – default (basic mode) and enhanced mode. This is selected by the M (mode) bit in TMC 3A variant 0 – see **Table 18**. For TMC 3A variant 1, see **Table 19**. In the basic mode, there are at least eight non-TMC groups broadcast between 8A TMC groups. In enhanced mode, the gap parameter (G), activity time (Ta), window time (Tw) and delay time (Td) timing parameters are broadcast. There is a trade-off between the number of TMC groups transmitted per second, which governs how fast traffic messages appear, the overall RDS data carrying capacity and the requirements of the other groups.

AID 0093

Group 12A is an Open Data Application (ODA), so is not specified in the RDS specification. This group is used to provide information and the frequency of the DAB multiplex that the current FM station also broadcasts on. I will look at this in Part 3. ●

Table 15: Definition of Block D for Group 2A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Radio Text message T3=0 T2=0 T1=0 T0=0 Character position 3 T3=0 T2=0 T1=0 T0=1 Character position 7 ..... T3=1 T2=1 T1=1 T0=1 Character position 63								Radio Text message T3=0 T2=0 T1=0 T0=0 Character position 4 T3=0 T2=0 T1=0 T0=1 Character position 8 ..... T3=1 T2=1 T1=1 T0=1 Character position 64							

Table 16: Definition of Block B for Group 3A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 3A				B_0	TP	PTY programme type					A3	A2	A1	A0	B_0
0	0	1	1	0							Application Identification (AID)				

Table 17: Definition of Block D for Group 3A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Application Identification (AID) numbers used in UK 0093 – Cross referencing FM to DAB (12A group) used by BBC. CD46 – ODA transmissions for RDS-TMC using ALERT protocol (group 8A).															

Table 18: Definition of Block C for Group 3A with AID = CD46 (TMC variant 0)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
V = 0	V = 0	X	X	Location Table Number						AFI	M	I	N	R	U

V = Variant code, 00 = TMC data
X = Reserved for future use
AFI = Alternative frequency indicator
M = Mode of transmission (1 = enhanced mode)
I = International location map
N = National location map
R = Regional location map
U = Urban location map
Note – more than one map can be selected

Table 19: Definition of Block C for Group 3A with AID = CD46 (TMC variant 1)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
V = 0	V = 1	G		SID						Ta		Tw		Td	

V = Variant code, 01 = TMC transmission mode timing
G = Gap parameter
SID = TMC service identifier
Ta = Activity time
Tw = Window time
Td = Delay time

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What's new in the world of radio communications

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■ Roger Thomas concludes his look at decoding RDS

Decoding RDS Part 3

In the concluding part of his three-part series on decoding RDS data, Roger Thomas looks at the background to this data system that was developed to make VHF FM broadcast receivers more user-friendly.

In *Decoding RDS Part 1* (*RadioUser*, May 2016: 50-52), I looked at the radio data system (RDS) subcarrier, data groups and blocks, switched Programme Identification (PI) and RDS group types. In *Part 2* (*RadioUser*, June 2016: 54-56), I looked at the signalling of Traffic Announcements (TA), Alternative Frequencies (AF), Programme Services (PS) and radio text messages. This time, I look at the signalling of the date and time, location and Enhanced Other Network data (EON).

RDS Group 4A

Group 4A is used to transmit the time and date every minute. Time is in UTC and local time. The local time is UTC with a time offset. This offset is transmitted as the difference between UTC and local time in half-hour steps.

Table 20: Definition of Block B for Group 4A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 4A				B_0	TP	PTY programme type					Not defined			2^{16}	2^{15}
0	1	0	0	0										MJD	

Table 21: Definition of Block C for Group 4A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^4
Modified Julian Day Code (start date March 1st 1900)															UTC hour

Table 22: Definition of Block D for Group 4A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
2^3	2^2	2^1	2^0	2^5	2^4	2^3	2^2	2^1	2^0	±	2^5	2^4	2^3	2^1	2^0
UTC hour code (0 to 23)				UTC minute code (0 to 9)						Local time offset (in half-hour steps) b05: 0 = plus, 1 = minus					

Table 23: Definition of Block B for Group 8A (TMC)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 8A				B_0	TP	PTY programme type					T	F	DP		
1	0	0	0	0											

Table 24: Definition of Block C for Group 8A (TMC)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
D	±	Extent			Event table										

Table 25: Definition of Block D for Group 8A (TMC)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Location table															

Bit 5 in Block D determines if this is a positive or negative time offset.

The date is transmitted in Modified Julian Day (MJD) code, where today's date is encoded as the number of days that have occurred since March 1st 1900. The date is locked to UTC rather than local time so that the date will change at UTC midnight, not midnight local. See **Tables 20, 21 and 22** for the definitions of Group 4A Blocks B, C and D.

RDS Group 8A TMC

In the UK, traffic information is provided by two Traffic Message Channel (TMC) service providers – INRIX (previously, this was IT IS until it was bought out by INRIX) and Trafficmaster. Both are commercial services and charge for the service either by subscription or with a single lifetime fee included in the purchase price of the satnav. TMC data is independent of the radio network and is entirely separate of any voiced traffic announcements.

Trafficmaster uses a network of traffic flow monitoring sensors to provide real-time traffic information on vehicle speed. Measuring vehicle speed gives a good indication of delays or congestion. At the time of writing, Trafficmaster's infrared measuring sensors and number plate recognition technology covered "*100% of the UK Motorways and 95% of Trunk Roads*."

www.teletrac.co.uk/trafficmaster-traffic

Because Trafficmaster uses regional radio networks to broadcast TMC data, the service needs to transmit PI numbers and frequencies for alternative sources of TMC data. **Fig. 6** shows that when listening to GEM 106, an alternative source for TMC information is given as C36E, which is the PI number for the Heart radio network.

INRIX uses traffic data obtained in real-time from sensors installed on GPS enabled fleet vehicles, including National Express and Eddie Stobart. INRIX uses the Classic FM radio network to broadcast TMC, so does not need to transmit alternative sources for its TMC data because Classic FM has national coverage.

Traffic Message Channel information uses Group 8A and the Agreed Layer for the European RDS-TMC (ALERT) protocol to provide traffic information text. The ALERT protocol defines the coding of several hundred pre-defined traffic messages and database containing location names. The Location Table

Number (LTN) is transmitted in Block C of a Group 3A. See **Tables 23, 24 and 25** for the definitions of Group 8A (TMC) Blocks B, C and D.

Traffic Events

The T bit (**Table 23**) selects user or tuning message. The F bit determines whether this is a single message or part of a group message. The DP bit stands for duration and persistence; it contains information about the timeframe of the traffic event. If all bits are set to 0, then this indicates no duration given. The D bit (**Table 24** Block C) informs the satnav that it needs to recalculate an alternative route to avoid this location. The ± bit indicates the direction of the growth of a queue; this is usually in the opposite direction to normal traffic flow.

The extent data identifies adjacent locations that are affected. The event data contains the 11-bit event code, which is looked up on the local event database and gives details of the traffic problem and its severity. Up to 2,048 different traffic and weather related messages are stored in this database. These messages are not specific to any country but include all eventualities.

The location table (Block D) contains the 16-bit code that retrieves a predefined location from the database of where the traffic problem is situated. This location database is not encrypted, contrary what you might have read. However, in the UK, these databases are proprietary and therefore not publicly available. Other countries make their location database available for free, for example, Germany and Italy.

RDS Group 14A EON

The Enhanced Other Network (EON) feature is used to update the information stored within an RDS receiver about radio services available on other radio networks. This EON data is continually sent. The BBC network carries information about BBC networks and BBC local radio stations as well as information for Classic FM. This information for the other network includes the radio station name, Programme Identification (PI) number, transmitter frequencies, traffic announcement identification and programme type. For some stations, Programme Item Number (PIN) information is transmitted giving the start time of the current programme.

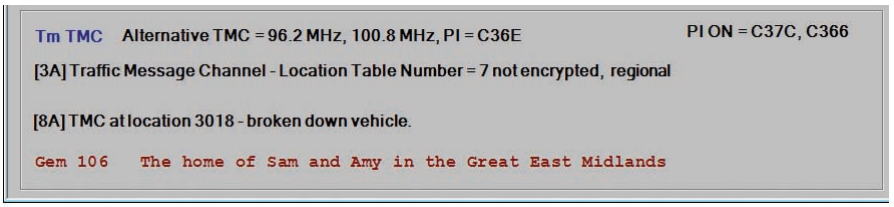
Tm TMC Alternative TMC = 96.2 MHz, 100.8 MHz, PI = C36E
PI ON = C37C, C366
[3A] Traffic Message Channel - Location Table Number = 7 not encrypted, regional
[8A] TMC at location 3018 - broken down vehicle.
Gem 106 The home of Sam and Amy in the Great East Midlands

Fig. 6: TMC Trafficmaster data broadcast by Gem 106.

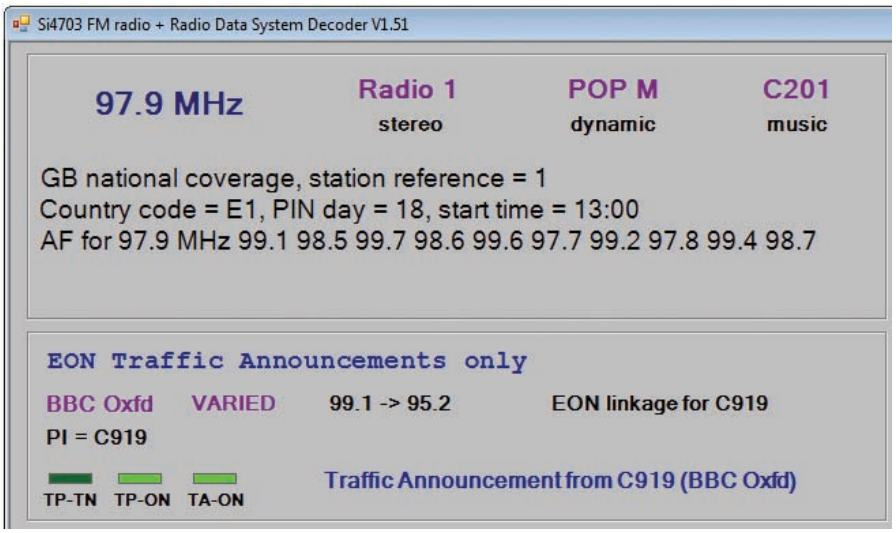

Fig. 7: Radio 1 showing RDS information and EON data for BBC Oxford.

Table 26: Definition of Block B for Group 14A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group type				B_0	TP (tn)	PTY programme type for tuned network					TP (on)	V3	V2	V1	V0
1	1	1	0	0								variant code (VC)			

Table 27: Definition of Block C for Group 14A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
VC = 0000 PS (on) character position 1 VC = 0001 PS (on) character position 3 VC = 0010 PS (on) character position 5 VC = 0011 PS (on) character position 7 VC = 0100 Alternative Frequency (on) VC = 0101 tuning frequency (tn) VC = 0110 tuning frequency (tn) VC = 0111 tuning frequency (tn) VC = 1000 tuning frequency (tn) VC = 1001 tuning frequency (tn)								VC = 0000 PS (on) character position 2 VC = 0001 PS (on) character position 4 VC = 0010 PS (on) character position 6 VC =0011 PS (on) character position 8 VC = 0100 Alternative Frequency (on) VC = 0101 mapped FM frequency (on) VC = 0110 mapped FM frequency (on) VC = 0111 mapped FM frequency (on) VC = 1000 mapped FM frequency (on) VC = 1001 mapped AM frequency (on)					
VC = 1010 not allocated VC = 1011 not allocated VC = 1100 linkage information VC = 1101 [b15:b11 – PTY (on)], [b10:b01 – reserved], [b00 – TA(on)] VC = 1110 Programme Item Information (on) VC = 1111 reserved for use by broadcasters on - other network tn - tuned network															

RDS receivers that implement the EON feature allow the receiver to be tuned to one radio station (or listening to CD/MP3 player) and automatically receive traffic announcements from another radio station. EON will inform the receiver which BBC local station is broadcasting traffic information.

If the traffic/travel (TP/TA) function is selected and, for example, the user is listening to Radio 2, when a nearby local radio station indicates it is broadcasting a travel announcement, then the receiver will first check that the local station has been previously received and check reception. If the local radio can be received, then the receiver switches from Radio 2 to the local radio station. At the end of the traffic announcement, the FM receiver will switch back to Radio 2.

EON alternative frequencies are transmitted as a frequency list or a mapped frequency where the tuned network frequencies are associated with frequencies of the other network. The frequency sent is not the actual frequency – unlike digital audio broadcasting (DAB) – but as a number as previously described in Table 7 (*Decoding RDS Part 2*, *RadioUser*, June 2016: 54).

See **Tables 26, 27** and **28** for the definitions of Group 14A Blocks B, C and D.

Travel Information

If the TP (Traffic Programme) flag is on for the tuned programme service, this indicates there will be traffic announcements on this radio station. If this flag is off, this does not mean that the station does not broadcast traffic information, only that they are not RDS flagged. BBC national networks do not flag their own traffic announcements. Therefore, if you are listening to a BBC local radio station, the receiver cannot switch to a BBC national network when they broadcast traffic announcements.

Fig. 7 for Radio 1 shows the TP-TN (tuned network) flag is off and traffic programme flag for the 'other network' (TP-ON) is on. In this case, the other network is BBC Radio Oxford – you can see EON information regarding PI number, programme type and mapped frequencies for tuning from Radio 1 to BBC Radio Oxford. This information is continually sent and stored in the RDS receiver, not just when there is a traffic announcement.

The traffic announcement for BBC Oxford being broadcast is signalled by setting the TA other network flag (Group 14B) with the PI number for the other network (C919) sent in Block D. If the TP/TA function is active, then the RDS receiver would check to see if BBC Oxford has been received successfully with frequencies previously provided by EON and, if so, switch to Radio Oxford for the duration of the traffic announcement.

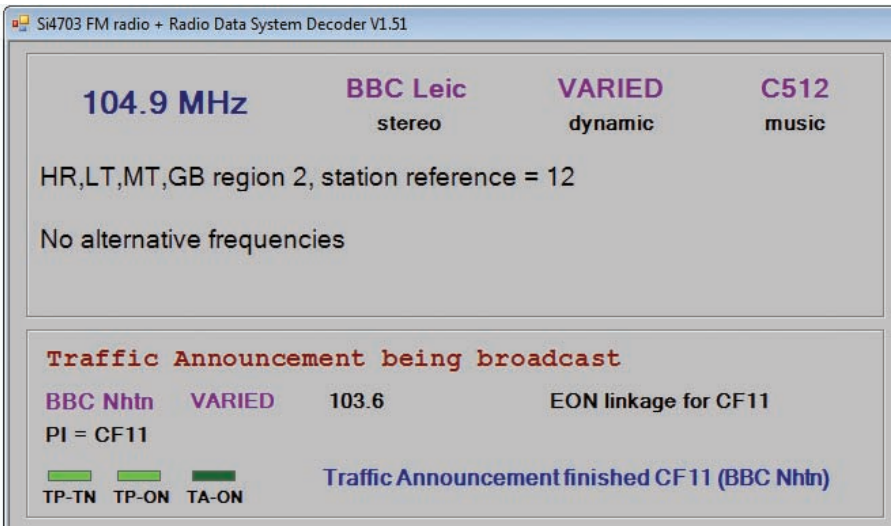

Fig. 8: BBC Radio Leicester broadcasting a traffic announcement.

Table 28: Definition of Block D for Group 14A

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Country code of other network				Coverage area of other network				Radio station reference number of other network							

Table 29: TP and TA Traffic Flags for Tuned Network

TP flag	TA flag	Meaning
Off	Off	No traffic announcements or EON.
Off	On	Traffic announcements via EON.
On	Off	Traffic announcements are broadcast.
On	On	Traffic announcement being broadcast.

Table 30: Definition of Block B for Group 14B

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 14B				B_0	TP (tn)	PTY programme type for tuned network					TP	TA	Not used		
1	1	1	0	1							For other network				

See **Table 29** for the TP and TA traffic flags for the tuned network and **Table 30** for the definition of Group 14B Block B.

RDS Group 12A ODA

Group 12A is used by the BBC national networks to broadcast information to a suitably equipped FM/DAB receiver detailing where the current FM station can be found on DAB. If the E/S (Ensemble/Service) flag is 0, then the information relates to the frequency of the DAB multiplex where the same FM programme content is being broadcast. Block C's 16 bits carry the actual frequency of the DAB multiplex – not a frequency code as used for FM broadcasts.

This frequency is transmitted as an 18-bit unsigned binary number with the two higher order bits carried in Block B. If the E/S flag is set to 1, this provides DAB multiplex service information but, at present, I have not seen any such DAB information.

Block D is the ensemble (multiplex) PI number. For the BBC national DAB multiplex, this is CE15. At present, only the BBC national networks transmit this information but it is likely the BBC local stations will also start to carry this DAB information because these local stations are carried on commercial multiplexes and not on the BBC multiplex.

Table 31: Definition of Block B for Group 12A (FM/RDS)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 12A				B_0	TP	PTY programme type					E/S	mode		2^{17}	2^{16}
1	1	0	0	0							0			Frequency	

E/S flag = 1 – DAB service information
Variant code 0 = multiplex identifier Block C
Variant code 1 = linkage information Block C
Variant codes 2 to 15 = reserved for future definition

Table 32: Definition of Block B for Group 12A (FM/RDS)

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
Group 12A				B_0	TP	PTY programme type					E/S	Variant code			
1	1	0	0	0							1				

See **Tables 31** and **32** for the definitions of Group 12A (FM/RDS) Block B.

Tick Mark

The Digital Radio Certification Mark ('tick mark') that is being introduced to give consumers confidence that the DAB/FM radio they are buying is 'future-ready' includes the requirement to decode RDS and to list the radio stations that are available on both FM and DAB.

Selection is based on choosing the wanted radio station's name from a list (no need to know the broadcast frequency or multiplex) and, if the radio station also broadcasts on FM, DAB or DAB+, for the receiver to select the best quality source. As part of this certification 'service following' is required for in-vehicle receivers to allow intelligent, seamless switching between DAB and FM and also between DAB multiplexes. **Fig. 9** shows examples of RDS data for DAB broadcast by Radio 1 on the BBC national network.
www.getdigitalradio.com/industry

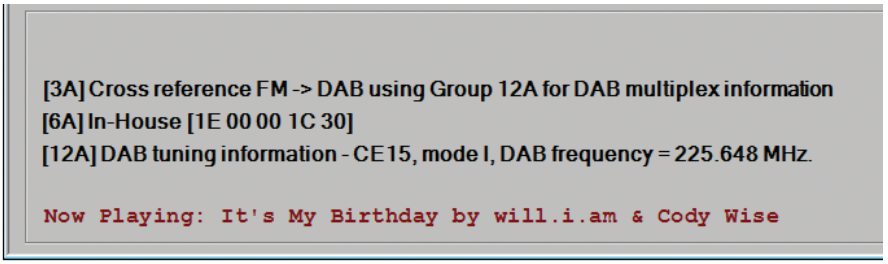
[3A] Cross reference FM -> DAB using Group 12A for DAB multiplex information
[6A] In-House [1E 00 00 1C 30]
[12A] DAB tuning information - CE15, mode I, DAB frequency = 225.648 MHz.
Now Playing: It's My Birthday by will.i.am & Cody Wise

Fig. 9: Examples of RDS data for DAB broadcast by Radio 1 on the BBC national network.

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The Editor's decision is final and no correspondence will be entered into.

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